United States Environmental Protection Agency | *Office of Water 4303* | *EPA-821-F-97-011 November 1997*

EPA

FACT SHEET

The Pulp and Paper Industry, the Pulping Process, and Pollutant Releases to the Environment

Summary

This fact sheet provides some basic information about the U.S. pulp and paper industry, describes how pulp mills bleach the pulp, and describes where in the pulp and paper-making process toxic pollutants are found.

A Major American Industry

U.S. pulp and paper mills are a world leader in the production of pulp and paper. These mills produce 9 million tons of pulp annually and 26 billion newspapers, books, and magazines. They account for 35% of pulp produced in the world and make up 16% of the pulp mills in the world.

U.S. pulp and paper mills are the source of significant amounts of pollutants that are released to the environment. These mills are the source of approximately 245,000 metric tons of toxic air pollutants that are released annually and 19 mills are associated with dioxin-based fish advisories.

American pulp and paper mills are an important employee. They are one of the nation's largest industries made up of approximately 565 manufacturing facilities located in 42 states and they employ over 200,000 people.

Pulp Production: The Pulping Process

Wood consists of two primary components: cellulose and lignin. Cellulose, which is the fibrous component of wood, is used to make pulp and paper. Lignin is the "glue" that holds wood fibers together. Pulping is the process which reduces wood to a fibrous mat by separating the cellulose from the lignin.

Pulping processes are generally classified as chemical, mechanical, or semi-chemical. The three chemical pulping methods are known as kraft, sulfite, and soda. Of these, the kraft and sulfite processes are most common. As described below, there are generally 3-steps in the pulping process:

Step 1: Initial Processing

In chemical pulping, wood is cooked in a "digester" at elevated pressure with a solution of the appropriate chemicals which dissolve the lignin and leave behind the cellulose. The cooking process results in emissions of a variety of hazardous air pollutants including formaldehyde, methanol, acetaldehyde, and methyl ethyl ketone.

In mechanical (or "groundwood") pulping, the wood is pressed against a grinder which physically separates the fibers. Mechanical pulping, which is energy intensive, produces an opaque product which is weak and discolors easily when exposed to light.

Semi-chemical pulping uses a combination of chemical and mechanical methods. The wood chips are partially cooked with chemicals, and the remainder of the pulping is accomplished mechanically.

Step 2: Washing the Pulp

After the wood is pulped, the pulp that is created is washed to remove the dissolved lignin and chemicals. In the washing process, the pulp is passed through a series of washers and screens. The washing process occurs at high temperatures which generates a large volume of exhaust gases containing hazardous air pollutants which are released to the atmosphere.

The liquid that results from the washing process contains lignin as well as the chemicals used to separate the lignin from the cellulose. The chemical recovery processes used to recover those chemicals also results in emissions of hazardous air pollutants.

Step 3: Bleaching the Pulp

After washing, if a white product is desired, the pulp must be bleached to remove color associated with remaining residual lignin. The three general approaches to bleaching are:

Elemental Chlorine Bleaching is the process currently in place at some existing bleaching plants, and uses chlorine (Cl_2) and hypochlorite to brighten the pulp. When elemental chlorine and hypochlorite react with the lignin, they form chlorinated pollutants such as chloroform, dioxins, and furans in the wastewater stream.

Elemental Chlorine Free Bleaching (ECF) replaces chlorine with chlorine dioxide as a bleaching agent and hypochlorite in no longer used. The use of ECF bleaching results in reduced levels of chlorinated pollutants in the wastewater stream.

Totally Chlorine Free (TCF) bleaching uses no chlorinated bleaching agents to bleach the pulp. Instead, bleaching agents such as oxygen and peroxide are used. TCF bleaching eliminates chlorinated pollutants in the wastewater stream.

Typically, in the bleaching process, the bleaching chemicals are injected into the pulp, and the resulting mixture is washed with water. This process occurs several times and generates a large volume of liquid waste. Additionally, vents from the bleaching tanks emit hazardous air pollutants including chloroform, methanol, formaldehyde, and methyl ethyl ketone.

Depending on the bleaching chemicals used, the waste stream from the bleaching process may contain chlorine compounds and organics. The mixture of chemicals may result in the formation of a number of toxic chemicals (such as dioxins, furans, and chlorinated organics). Although this effluent is generally released to a waste water treatment plant, the chemicals named above simply "pass through" (i.e. the treatment plant does not reduce the concentrations of these pollutants) the plant and accumulate in the rivers and oceans to which the treatment plant discharges.

Toxic Air and Water Pollutants Generated at Pulp and Paper Mills

Pollutants are generated at several sites in the production of pulp and paper:

- Volatile organic compounds (VOC's) play a significant role in the chemical reactions that form ozone. Ozone is not emitted directly into the atmosphere. It is formed when emissions of nitrogen oxides and VOC's react in the presence of sunlight. While beneficial in the upper atmosphere, ozone in the lower atmosphere can cause a variety of health problems because it damages lung tissue, reduces lung function, and adversely sensitizes the lungs to other irritants.

- Total reduced sulfur is the pollutant that is associated with foul odors from pulp and paper mills.

- Hazardous air pollutants are also known as air toxics. These are pollutants which are known or suspected to cause cancer or other serious health effects (such as birth defects or reproductive effects).

- Exposure to particulate matter has been linked with adverse health effects, including aggravation of existing respiratory and cardiovascular disease and increased risk of premature death.

- Adsorbable Organic Halides (AOX's) exhibit toxicity and may bioaccumulate in fish tissue. This may present a risk to human health if large amounts of fish exposed to these substances are consumed.

- Chloroform is a probable human carcinogen. Short term exposure to chloroform can adversely effect the central nervous system and result in dizziness and headaches. Long term exposure by inhalation can adversely effect the liver and cause hepatitis and jaundice.

- Exposure to dioxin and furan can cause skin disorders, cancer, and reproductive effects. These pollutants can also affect the immune system.